Phase and Sad divisions
(UMR1213 Herbivores, Selmet, Tandem, AFPA)

Prospects for agroecology and industrial ecology for animal production in the 21st century

Agroecology and industrial ecology can be viewed as complementary means for enhancing food security while reducing the environmental footprint of animal farming systems. On the basis of a crop production study by Altieri, we proposed 5 principles to underpin the design of ecology-driven animal production systems. We then discussed how these principles articulate to shape environmental, social and economic performance in different types of production systems.

Animal production is and will increasingly be constrained by competition for natural resources, changing sociocultural values, and the need to operate in a carbon-constrained economy. Agroecology and industrial ecology can help design sustainable farming systems adapted to this context. Agroecology stimulates natural processes. Industrial ecology closes system loops, thereby reducing demand for raw materials, lowering pollution, and saving on waste treatment. Animal farming systems have so far been ignored in most agroecological thinking. On the basis of a study by Altieri (2002), who identified the key ecological processes to be optimized, we proposed 5 principles for the design of ecology-driven animal production systems. We then discussed how these principles articulate to shape environmental, social and economic performance in six animal production systems (ruminants, pigs, rabbits, aquaculture) covering a long gradient of intensification.

Organizing the production cycle of sheep to enhance the use of natural resources

The 5 principles proposed are: i) adopting and integrated approach to animal health management practices, ii) decreasing the inputs needed for production, iii) decreasing pollution by optimizing farming systems metabolism, iv) enhancing diversity within animal production systems to strengthen their resilience, v) preserving biological diversity in agroecosystems by adapting management practices.

Alternatives to chemical drugs have only recently been investigated, and the results are seldom transferable to farming practices. Conversely, the two principles on economy of inputs and reduction of pollution nearly always emerge due to economic and regulatory constraints. Integrating cropping into livestock systems allows better regulation of biochemical cycles and nutrient fluxes to the atmosphere and hydrosphere. The sustainability of many ecological functions and ecosystem services hinges on maintaining biological diversity in agroecosystems. Labor is qualitatively different from that in conventional systems, as the farmers have to lead tight monitoring of system performance. Finally, we highlight that the development of these alternatives implies shifts in the positions adopted by technicians, extension services, researchers and policymakers. It calls to consider animal production systems not only holistically but also in terms of the diversity of their local and regional conditions.

The review paper we published in *Animal* is being adapted for the French journal *Inra Productions Animales*. Scientists from 3 Inra divisions (Animal physiology and farming systems, Science for action & development, Animal health) are currently setting up a research agenda in agroecology and industrial ecology. We stress the need for integrated research into the adaptive capacities of the animals, but also call for innovative research on resources and farming systems including multicriteria evaluation, and on the upscaling of ecology-based animal production systems. Scientists from 7 Inra divisions will host a workshop in June to highlight concepts and research lines that contrast with more conventional animal science approaches, and to facilitate inter-disciplinarity.

Publication/patent: Dumont B., Fortun-Lamothe L., Jouven M., Thomas M. & Tichit M., 2013. Prospects for agroecology and industrial ecology for animal production in the 21st century. *Animal* doi :10.1017/S1751731112002418 (online 21/12/2012)

Contact: Dumont Bertrand, bertrand.dumont@clermont.inra.fr, UMR1213 Herbivores, F-63122 Saint-Genès-Champanelle, France.